

## CLAIMS

1. A loudspeaker system comprising:

at least one electroacoustical transducer for converting an input electrical signal into corresponding acoustic output;

an enclosure divided into at least first, second and third subchambers by at least first and second dividing walls;

said first dividing wall supporting and coacting with said at least one electroacoustical transducer to bound said first and said second subchambers, at least one passive acoustic radiator specifically designed to realize a predetermined acoustic mass and intercoupling said second and third subchambers;

at least a second passive acoustic radiator specifically designed to realize a predetermined acoustic mass and intercoupling at least one of said second and third subchambers with the region outside said enclosure;

at least a third passive acoustic radiator specifically designed to realize a predetermined acoustic mass and intercoupling said first and second subchambers;

each of said subchambers having the characterization of acoustic compliance;

said first and second passive acoustic radiator masses interacting with second and third subchamber compliances to form two Helmholtz-reflex tunings at two spaced frequencies in the passband of said loudspeaker;

said at least a third passive acoustic radiator intercoupling said first and second subchambers to form a third Helmholtz-reflex tuning at a frequency lower than that of said first and second passive acoustic radiators.

2. The loudspeaker of claim 1 wherein said passive acoustic radiators have the characteristic of acoustic mass and are selected from the group consisting of vents, ports, and suspended passive diaphragms.

3. The loudspeaker of claim 1 wherein said at least a second passive acoustic radiator intercouple said third subchamber with the region outside said enclosure.

*fig 7*

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4. The loudspeaker of claim 1 wherein said at least a second passive acoustic radiator intercouples said second subchamber with the region outside said enclosure.

5. The loudspeaker of claim 4 wherein another of said at least a second passive acoustic radiator intercouples said third subchamber with the region outside said enclosure.

6. A loudspeaker system comprising:

at least one electroacoustical transducer for converting an input electrical signal into corresponding acoustic output;

an enclosure divided into at least first, second, third, and fourth subchambers by at least first, second, and third dividing walls;

said first dividing wall supporting and coacting with said at least one electroacoustical transducer to bound said first and said second subchambers;

at least one passive acoustic radiator specifically designed to realize a predetermined acoustic mass and intercoupling said second and third subchambers;

at least a second passive acoustic radiator specifically designed to realize a predetermined acoustic mass and intercoupling at least one of said second, third, or fourth subchambers with the region outside said enclosure;

at least a third passive acoustic radiator specifically designed to realize a predetermined acoustic mass and intercoupling said first and second subchambers;

each of said subchambers having the characterization of acoustic compliance;

said passive acoustic radiator masses interacting with first, second, third, and fourth subchamber compliances to form four Helmholtz-reflex tunings at four spaced frequencies in the passband of said loudspeaker.

7. The loudspeaker of claim 6 wherein said passive acoustic radiators have the characteristic of acoustic mass and are selected from the group consisting of vents, ports, and suspended passive diaphragms.

8. A loudspeaker system comprising:

at least one electroacoustical transducer for converting an input electrical signal into a corresponding acoustic output;

an enclosure divided into (n) number of subchambers by at least  $n-1$  number of dividing walls with  $n \geq 3$ ;

a first dividing wall supporting and coacting with said at least one electroacoustical transducer to bound a first (n1) and a second (n2) subchamber;

at least a first passive acoustic radiator designed to realize a predetermined acoustic mass and intercoupling said first (n1) and second (n2) subchambers;

at least a second passive acoustic radiator specifically designed to realize a predetermined acoustic mass and coupling each subchamber other than said first (n1) subchamber to a region outside each said subchamber;

at least a third passive acoustic radiator specifically designed to realize a predetermined acoustic mass and intercoupling at least one of said subchambers, other than said first (n1) subchamber, to the region outside said enclosure;

each of said subchambers having the characterization of acoustic compliance;

said passive acoustic radiator masses interacting with subchamber compliances to form a total of (n) Helmholtz-reflex acoustic filters of which the output of said at least one electroacoustic transducer and said at least a first passive acoustic radiator must pass through before exiting the enclosure.

9. The loudspeaker of claim 8 wherein said passive acoustic radiators have the characteristic of acoustic mass and are selected from the group consisting of vents, ports, and suspended passive diaphragms.

10. A loudspeaker system comprising:

at least one electroacoustical transducer having a vibratable diaphragm for converting an input electrical signal into a corresponding acoustic output signal;

an enclosure divided into at least first, second and third subchambers by at least first and second dividing walls;

said first dividing wall supporting and coacting with said first electroacoustical transducer to bound said first and said second subchambers;

at least a first passive radiator specifically designed to realize a predetermined acoustic mass and intercoupling said second and third subchambers;

at least a second passive radiator specifically designed to realize a predetermined acoustic mass and intercoupling at least one of said second and third subchambers with the region outside said enclosure;

at least a third passive radiator specifically designed to realize a predetermined acoustic mass and intercoupling said first and second subchambers;

each of said subchambers characterized by acoustic compliance;

said passive acoustic radiator masses and said acoustic compliances selected to establish three spaced frequencies in the passband of said loudspeaker system at which the deflection characteristic of said vibratable diaphragm as a function of frequency has a minimum.

11. The loudspeaker of claim 10 wherein said passive acoustic radiator has the characteristic of acoustic mass and is selected from the group consisting of vents, ports, and suspended passive diaphragms.

12. The loudspeaker of claim 11 wherein said at least one additional passive acoustic radiator intercouples said third subchamber with the region outside said enclosure.

Fig 8 13. The loudspeaker of claim 11 wherein said at least one additional passive acoustic radiator intercouples said second subchamber with the region outside said enclosure.

Fig 9 14. The loudspeaker of claim 13 wherein a second of said at least one additional passive acoustic radiator intercouples said third subchamber with the region outside said enclosure.

15. A loudspeaker system comprising:  
at least one electroacoustical transducer having a vibratable diaphragm for converting an input electrical signal into a corresponding acoustic output signal;

10 an enclosure divided into at least first, second, third and fourth subchambers by at least first, second and third dividing walls;

said first dividing wall supporting and coacting with said at least one electroacoustical transducer to bound said first and said second subchambers;

15 at least one passive acoustic radiator specifically designed to realize a predetermined acoustic mass and intercoupling said second and third subchambers;

at least one additional passive acoustic radiator specifically designed to realize a predetermined acoustic mass and intercoupling said third and fourth subchambers;

20 at least a second additional passive acoustic radiator specifically designed to realize a predetermined acoustic mass and intercoupling at least one of said second, third, or fourth subchambers with the region outside said enclosure;

25 at least a third additional passive acoustic radiator specifically designed to realize a predetermined acoustic mass and intercoupling said first and second subchambers;

each of said subchambers having the characterization of acoustic compliance;

30 said passive acoustic radiator masses and said acoustic compliances selected to also establish at least four spaced frequencies in a passband of said

loudspeaker system at which the deflection characteristic of said vibratable diaphragm as a function of frequency has a minimum.

16. The loudspeaker of claim 15 wherein said passive acoustic radiator has the characteristic of acoustic mass and being selected from the group consisting of vents, ports, and suspended passive diaphragms.

17. The loudspeaker of claim 1 wherein at least a second of said at least one electroacoustical transducer is supported by and coacts with said first dividing wall such that said electroacoustical transducers bound said first and said second subchambers.

18. The loudspeaker in claims 17 wherein said electroacoustical transducers are mounted in an mechanical-acoustical parallel arrangement.

19. The loudspeaker in claims 17 wherein said electroacoustical transducers are mounted in an mechanical-acoustical series arrangement.

20. The loudspeaker in claims 18 and 19 wherein each of said electroacoustical transducers are adapted to receive said electrical input signal from separate amplifier channels.

21. A method for acousti-mechanically configuring a low range speaker system for use in an audio system which enables reduction of speaker size requirements for upper range speaker systems when using said low range speaker system as a subwoofer, said method comprising the steps of:

a) configuring said low range speaker system to include multiple, low pass acoustic filter structures to achieve at least a third order acoustic low pass characteristic;

b) configuring a transducer with a vibratable diaphragm to be filtered by said low pass acoustic filter structures; and

c) operating a low frequency passive acoustic radiator operating in parallel with said transducer such that said passive acoustic radiator is filtered by said low pass acoustic filter structures.

22. A method as defined in claim 21 including the step of configuring said low pass acoustic filter structures to achieve at least a fourth order acoustic low pass characteristic.

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23. A method for acousti-mechanically configuring a low range speaker system for use in an audio system to enhance audio output capability, said method comprising the steps of:

5 a) configuring said low range speaker system to include multiple, lowpass acoustic filter structures to achieve at least a third order acoustic low pass characteristic;

b) configuring a transducer with a vibratable diaphragm to be filtered by said low pass acoustic filter structures; and

10 c) operating a low frequency passive acoustic radiator in parallel with said transducer such that said passive acoustic radiator is filtered by said low pass acoustic filter structures.

24. A method as defined in claim 23 including the step of configuring said low pass acoustic filter structures to achieve at least a fourth order acoustic low pass characteristic.

15 25. The loudspeaker of claim 2 wherein:

said enclosure has outer side walls which bound said enclosure to the outside environment;

20 said at least one additional passive acoustic radiator being comprised of at least one compliant sheet that interouples said third subchamber through at least one of said outer side walls to the region outside said enclosure.

26. The loudspeaker of claim 25 wherein said at least one compliant sheet interouples said third subchamber through two of said outer side walls to the region outside said enclosure.

25 27. The loudspeaker of claim 25 wherein said at least one compliant sheet interouples said third subchamber through three of said outer side walls to the region outside said enclosure.

28. The loudspeaker of claim 25 wherein said at least one compliant sheet interouples said third subchamber through four of said outer side walls to the region outside said enclosure.

29. The loudspeaker of claim 25 wherein said at least one compliant sheet substantially forms at least one of the outer sidewalls.

30. The loudspeaker of claim 25 wherein said at least one compliant sheet substantially forms two of the outer sidewalls.

31. The loudspeaker of claim 25 wherein said at least one compliant sheet substantially forms three of the outer sidewalls.

32. The loudspeaker of claim 25 wherein said at least one compliant sheet substantially forms four of the outer sidewalls.

33. A method for acousti-mechanically configuring a low range speaker system for use in an audio system with the improvement of attenuating internal resonances and other unwanted output above an operating passband, said method comprising the steps of:

a) configuring said low range speaker system to include multiple, lowpass acoustic filter structures to achieve at least a third order acoustic low pass characteristic; and

b) configuring a transducer with a vibratable diaphragm for which all output of said vibratable diaphragm that is delivered to the region outside said low range speaker system is filtered by all of said low pass acoustic filter structures.

34. The method of claim 33 including the step of configuring said low pass acoustic filter structures to achieve at least a fourth order acoustic low pass characteristic.

35. The method of claim 34 including the further step of:

c) configuring a low frequency passive acoustic radiator operating in parallel with and intercoupling the same subchambers as said transducer such that the output of said passive acoustic radiator is also filtered by all of said low pass acoustic filter structures.